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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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Loudspeaker provided with a composed diaphragm structure

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Loudspeaker provided with a composed diaphragm structure

The invention relates to a loudspeaker provided with a chassis, a movable body, a resilient suspension for guiding the movable body with respect to the chassis along a translation axis and an electric actuator for driving the movable body along the translation axis.

5

Speakers of such a kind are generally known; e.g. the PCT Patent Application WO 96/14722 discloses such a loudspeaker. This known loudspeaker has a frame, a membrane and an electromagnetic driving unit. The membrane is formed by a conical body and has an outer circumferential edge and an inner circumferential edge. The driving unit is provided with a stationary part and a movable part. The stationary part includes a permanent magnet and a magnetic yoke and is secured to the frame. The movable part includes a voice coil and a cylindrical coil support. The membrane is at its outer circumferential edge connected to the frame by means of a flexible suspension and is at its inner circumferential edge adhered to the coil support, which in its turn is connected to the frame by means of a spider.

The conical membrane of the known loudspeaker has a certain height in order to obtain sufficient stiffness. The membrane must have a certain minimal stiffness in order to be able to move like a piston for not only low frequency reproduction but for the whole or at least the larger part of the audio spectrum.

For this reason there arise problems relating to the speaker's performance if a shallow speaker, i.e. a speaker having a small height, is required in certain applications.

25 An object of the invention is to improve the known loudspeaker such that it can be given a small height without deteriorating its sound performance.

This object is achieved with the loudspeaker according to the invention which is provided with a chassis, a movable body, a resilient suspension for guiding the movable body with respect to the chassis along a translation axis and an electric actuator for driving

the movable body along the translation axis, which movable body comprises a diaphragm structure having a centrally situated dome-shaped diaphragm and a decentralized cone-shaped diaphragm concentrically arranged with respect to the dome-shaped diaphragm, which cone-shaped diaphragm has a back portion and a front portion which is wider than the back portion, wherein both diaphragms are attached to each other near the back portion of the cone-shaped diaphragm, the cone-shaped diaphragm envioning the dome-shaped diaphragm and wherein the resilient suspension comprises a resilient element connecting the diaphragm structure to the chassis near the back portion of the cone-shaped diaphragm and a further resilient element connecting the diaphragm structure to the chassis near the front portion of the cone-shaped diaphragm.

Thus, the loudspeaker according to the invention is provided with a diaphragm structure which is composed of an outwardly convex, particularly dome-shaped, diaphragm and a cone-shaped diaphragm situated around the other diaphragm. This makes it possible to give the diaphragm structure of the movable body sufficient stiffness to prevent an undesired break-up, i.e. bending wave resonances, during mid and high frequency reproduction in the event of relatively flat loudspeaker constructions. In principle a cone-shaped diaphragm known per se may be used. The same applies to the dome-shaped diaphragm. A rigid dome-shaped diaphragm known per se may be used. Such diaphragms are for instance known from US-A 3,925,626. The loudspeaker according to the invention can be driven by a usual audio transformer of an amplifier system known per se.

A favorable embodiment of the loudspeaker according to the invention has the characteristic feature that the electric actuator comprises a stationary part which is secured to the chassis or to a stationary element fixed to the chassis and further comprises a translatable part which is secured to the dome-shaped diaphragm. Due to this feature the translatable part of the electric actuator extends into the space enveloped by the dome-shaped diaphragm.

It is to be noted that said US-A 3,925,626 discloses an all-frequency loudspeaker which has a domed diaphragm in substituting for the usual cone diaphragm of the prior art in order to get among others high fidelity sound. Secured to the underside of the diaphragm is a form which extends downwards into an air gap formed by a pole piece and a top ring of a magnet system and on which a voice coil has been wound. The device formed by the diaphragm and the form is suspended from a framework by means of a resilient suspension secured to both the diaphragm and the framework and a resilient support secured to both the form and the framework. A disadvantage of this known loudspeaker is its height, which has to be substantial in order to provide sufficient distance between the lower resilient

support and the toppling to realize the required travel of the diaphragm. Contrary to the acknowledged known devices the loudspeaker according to the invention has no suspension means secured to the coil support, and thus does not have the above-described disadvantage.

5 In a practical embodiment of the loudspeaker according to the invention the back portion of the cone-shaped diaphragm includes an inner circumferential edge to which an outer circumferential rim of the dome-shaped diaphragm is connected, preferably, said edge and rim being attached to each other by means of an adhesive, such as a glue. In this context it is also preferred to connect an inner circumferential brim of the resilient element of the resilient suspension to the inner circumferential edge of the cone-shaped diaphragm
10 and/or to the outer circumferential rim of the dome-shaped diaphragm. This can also be realized by means of a suitable adhesive.

In another practical embodiment the stationary part includes a magnetic yoke with a permanent magnet and the translatable part includes a coil support with a voice coil, which coil extends in an air gap of the magnetic yoke and has a coil axis coinciding with the
15 translation axis of the movable body.

It is to be noted that the loudspeaker according to the invention is suitable for sound reproduction in hifi, home, automotive, tv and multimedia systems and it is, as already indicated, particularly suitable for applications having very small built-in depths.

The invention also relates to a diaphragm structure intended for use in the
20 loudspeaker according to the invention. Particularly, the diaphragm structure according to the invention has the characterizing feature that it is composed of a central dome-shaped diaphragm and a cone-shaped diaphragm conically arranged with respect to the dome-shaped diaphragm. For a further description reference is made to Claim 6.

The invention further relates to a loudspeaker unit comprising the loudspeaker
25 according to the invention and also comprising a housing accommodating the loudspeaker.

It is noted in relation to the Claims that various combinations of characteristic features defined in the Claims are possible.

The above-mentioned and other aspects of the invention are apparent from and elucidated, by way of non-limitative examples, with reference to the embodiment described
30 hereinafter.

In the drawings:

Figure 1 shows an embodiment of the loudspeaker according to the invention in a diagrammatic cross-section, and

Figure 2 is a perspective elevational view of the loudspeaker of Fig.1 in an exploded view.

5

The electrodynamic loudspeaker according to the invention, shown in the Figures, comprises a chassis 2, a movable body 4 and an electromagnetic actuator 6. For forming a loudspeaker unit according to the invention, the loudspeaker may be
10 accommodated in a housing. To this end, the chassis 2 may be fixed in an appropriate opening in a wall of such housing. In Fig. 1, the housing is shown diagrammatically by means of a wall section 1 in broken lines.

The movable body 4 is provided with a three-dimensional diaphragm structure comprising a central dome-shaped diaphragm 8 and a cone-shaped diaphragm 10
15 concentrically arranged with respect to the dome-shaped diaphragm 8. The dome-shaped diaphragm 8 may be made of a metal, such as aluminium; a reinforced plastics; a pressed paper; or any other suitable material. The diaphragm 8 has a sufficient stiffness and may be provided with a central opening 8a covered by a dust cap 9 of any suitable material, such as paper, plastics, textile. The cone-shaped diaphragm 10 may be made of a pressed paper,
20 carbon fiber, polyglass, aluminium, or any other suitable material. The cone-shaped diaphragm 10 has a back portion 10_b and a front portion 10_f which is wider than the back portion 10_b. The dome-shaped diaphragm 8 and the cone-shaped diaphragm 10 are mutually secured at the back portion 10_b. For this reason the cone-shaped diaphragm 10 has an inner circumferential edge 10_i, while the dome-shaped diaphragm 8 has a corresponding outer
25 circumferential rim 8_o. The edge 10_i and the rim 8_o preferably have round cross sections such, that the edge 10_i and the rim 8_o fit each other. The edge 10_i and the rim 8_o are preferably glued to each other.

The loudspeaker further comprises a resilient suspension for suspending the movable body 4 from the chassis 2 and for guiding the movable body along a translation axis
30 T. The suspension includes a first resilient element 12a and a second resilient element 12b. The first resilient element 12a is a ring-like spider of which an inner circumferential brim 12a_i is attached to the edge 10_i and/or the rim 8_o and of which an outer circumferential brim 12a_o is attached to the chassis 2. For both attachments a glue may be used. The spider 12a

may be a known flexible corrugated body and ensures that the movable body 4 can perform well defined translation movements with respect to the chassis 2.

The second resilient element 12b has a roll structure known per se and formed, for example, from a bent rubber or foam annular strip. The second element 12b is secured,
5 for example glued, on its outer circumference to the chassis 2 and on its inner circumference to an outer circumferential edge 10_o of the cone-shaped membrane 10.

The actuator 6 essentially comprises two elements, namely a stationary actuator part 6a which is fixed to the chassis 2 and a translatable actuator part 6b which is connected to the movable body 4. One of the actuator parts - in this example the part 6a - is
10 provided with a permanent magnet 13, in this example annular of shape and axially polarized, and the other actuator part - in this example thus the part 6b - is provided with a magnet coil 14. The permanent magnet 13 is formed from an neodymium-iron-boron alloy and forms a magnetic yoke 13a with soft iron portions of the stationary actuator part 6a, which yoke defines an air gap 16. The magnet coil 14, being a cylindrical coil, also referred to as voice
15 coil, is situated on a coil support 14a, being a sleeve in this example, which is fixed to the dome-shaped diaphragm 8. A lead wire 17 connects the coil 14 by means of a connector 18 which is adhered to the chassis 2. When energizing the coil 14, both actuator parts 6a, 6b magnetically co-operate with each other over the air gap 16 for generating a driving force on the movable body 4 parallel to the translation axis T and thus on the dome-shaped diaphragm
20 8 and the cone-shaped diaphragm 10.

It is to be noted that the invention is not limited to the embodiment shown. For example the dome-shaped diaphragm and the cone-shaped diaphragm may be formed as an integral combination, thus comprising or consisting of a single diaphragm structure. Moreover, the loudspeaker unit may not only comprise one or more speakers but also one or
25 more passive radiators or bass reflex ports. Furthermore, the loudspeaker according to the invention is not limited to a certain power. For acoustical sound tuning purposes the dome-shaped diaphragm may be provided with perforations and/or a coating. For the same purposes the outer circumferential rim of the dome-shaped diaphragm need not to be a back edge of the dome-shaped diaphragm, but may be a rim parallel to the back edge.

CLAIMS:

1. A loudspeaker provided with a chassis, a movable body, a resilient suspension for guiding the movable body with respect to the chassis along a translation axis and an electric actuator for driving the movable body along the translation axis, which movable body comprises a diaphragm structure having a central dome-shaped diaphragm and a cone-shaped
5 diaphragm concentrically arranged with respect to the dome-shaped diaphragm, which cone-shaped diaphragm has a back portion and a front portion which is wider than the back portion, wherein both diaphragms are attached to each other near the back portion of the cone-shaped diaphragm, the cone-shaped diaphragm environing the dome-shaped diaphragm and wherein the resilient suspension comprises a resilient element connecting the diaphragm
10 structure to the chassis near the back portion of the cone-shaped diaphragm and a further resilient element connecting the diaphragm structure to the chassis near the front portion of the cone-shaped diaphragm.
2. A loudspeaker as claimed in Claim 1, wherein the electric actuator comprises a
15 stationary part secured to the chassis and a translatable part secured to the dome-shaped diaphragm.
3. A loudspeaker as claimed in Claim 1, wherein the back portion of the cone-shaped diaphragm includes an inner circumferential edge to which an outer circumferential
20 rim of the dome-shaped diaphragm is connected.
4. A loudspeaker as claimed in Claim 3, wherein the resilient element of the resilient suspension includes an inner circumferential brim which is connected to the inner circumferential edge of the cone-shaped diaphragm and/or the outer circumferential rim of
25 the dome-shaped diaphragm.
5. A loudspeaker as claimed in Claim 2, wherein the stationary part includes a magnetic yoke with a permanent magnet and the translatable part includes a coil support with

a voice coil, which coil extends in an air gap of the magnetic yoke and has a coil axis coinciding with the translation axis of the movable body.

6. A diaphragm structure presenting the features of the diaphragm structure
5 disclosed in the Claims 1 to 3 and thus constructed and evidently intended for use in the loudspeaker as claimed in any one of the preceding Claims.

7. A loudspeaker unit comprising the loudspeaker as claimed in any of the Claims 1 to 5 and comprising a housing accommodating the loudspeaker.

ABSTRACT:

A shallow loudspeaker provided with a chassis (2), a movable body (4), a resilient suspension for guiding the movable body with respect to the chassis along a translation axis (T) and an electric actuator (6) for driving the movable body along the translation axis. The movable body comprises a diaphragm structure having a central dome-shaped diaphragm (8) and a cone-shaped diaphragm (10) concentrically arranged with respect to the dome-shaped diaphragm. The cone-shaped diaphragm has a back portion (10_b) and a front portion (10_f) which is wider than the back portion. Both diaphragms are attached to each other near the back portion of the cone-shaped diaphragm, the cone-shaped diaphragm envioning the dome-shaped diaphragm. The resilient suspension comprises a first resilient element (12a) connecting the diaphragm structure to the chassis near the back portion of the cone-shaped diaphragm and a second resilient element (12b) connecting the diaphragm structure to the chassis near the front portion of the cone-shaped diaphragm.

(Fig. 1)

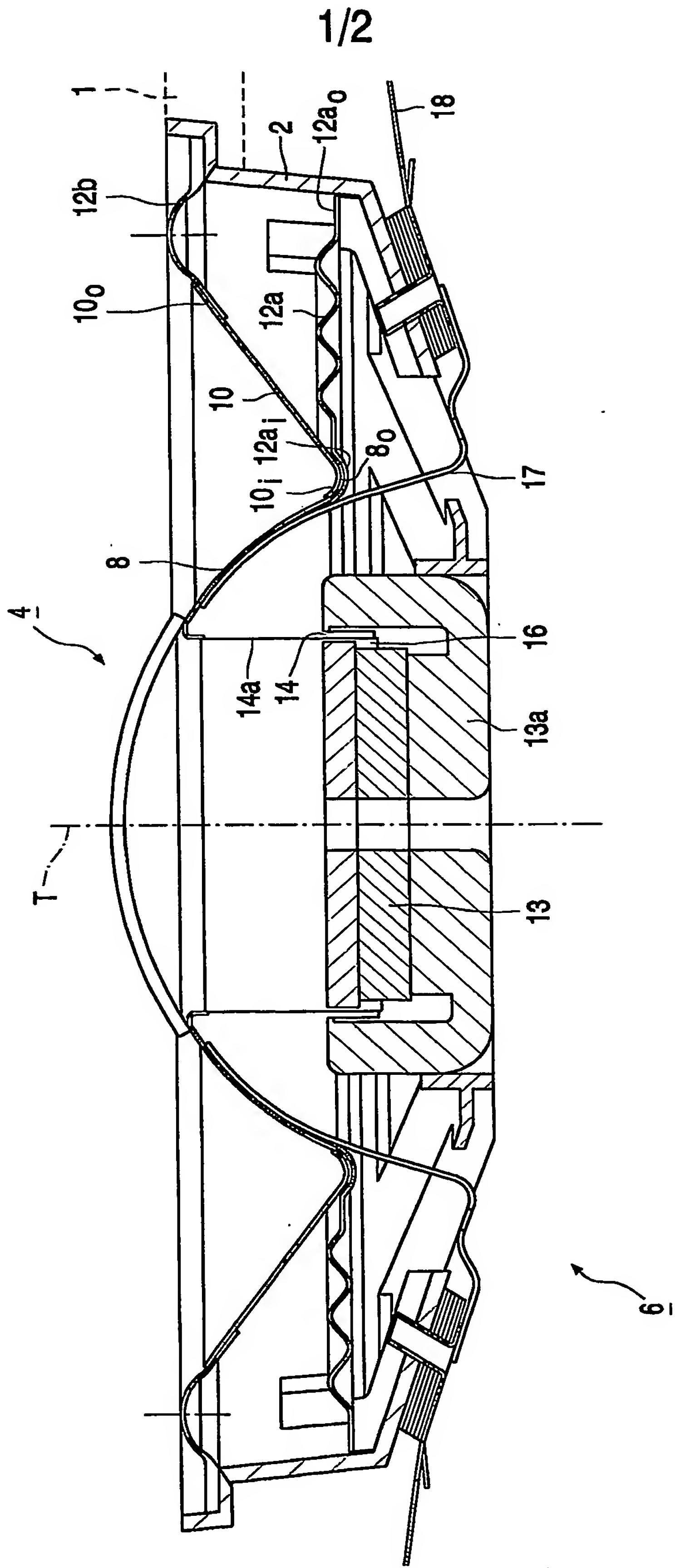


FIG. 1

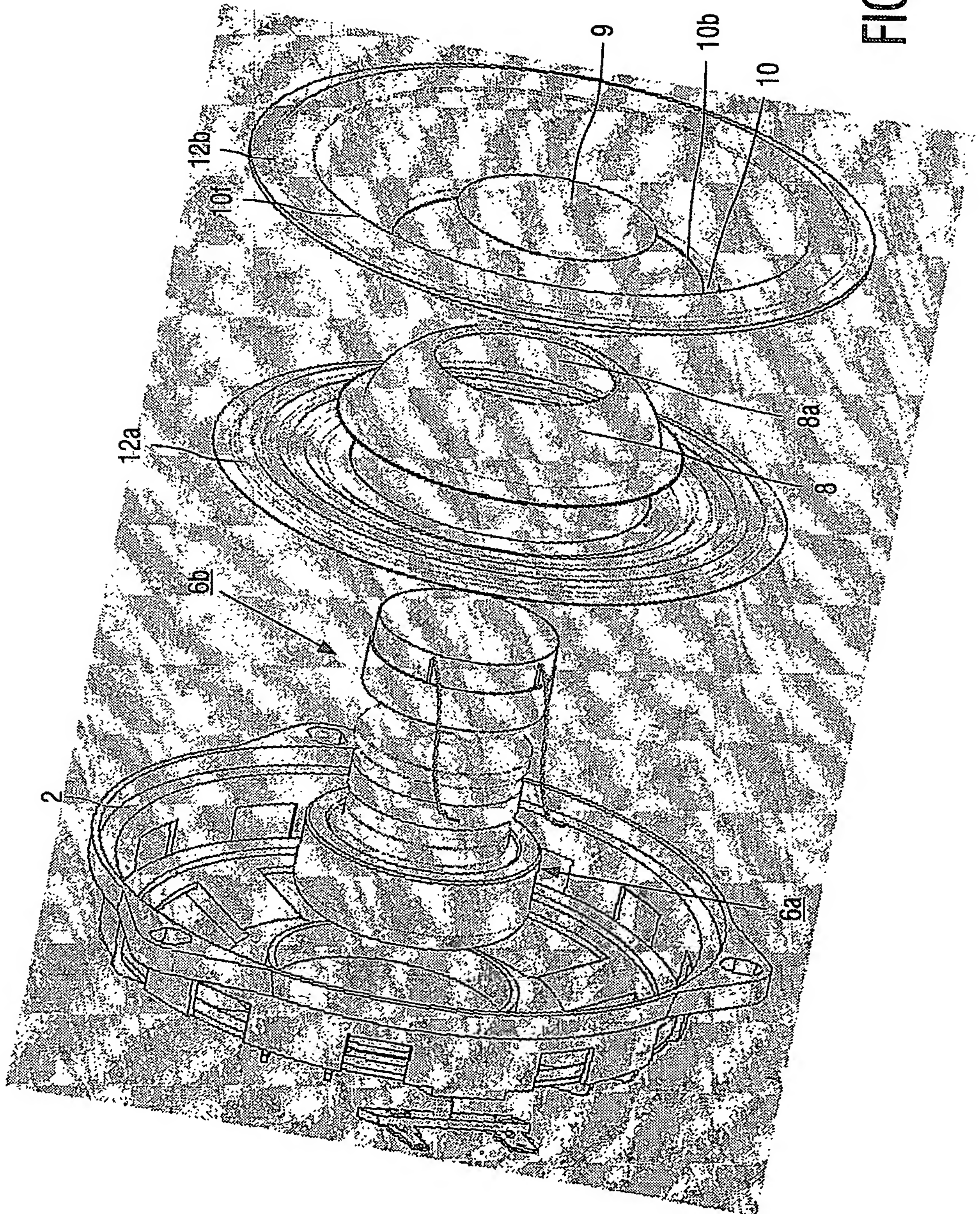


FIG.2

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